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A FIRST STUDY OF THE INFLUENCE OF THE STARVATION OF THE ASCENDANTS UPON THE CHARACTERISTICS OF THE DESCENDANTS—II[1]

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III. Presentation of Data and Comparison of Constants for Navy, White Flageolet and Ne Plus Ultra Beans.—*Continued*

B. Number of Ovules per Pod.

The nature of this and the following character has been discussed elsewhere.[2] There the data from which all the physical constants necessary in this study may be deduced, but not the constants themselves, are set forth. Tables IX–XI give these constants based on countings of ovules formed and seeds matured in 130,074 pods.

That the starvation of the individual affects not merely the number of pods which it produces but the characteristics of these pods as well is evident from a study of these tables, but is best brought out by a special kind of graph.

Reducing absolute to relative frequencies, we take the difference

Starved *less* fed

for each ovule grade. Such differences are shown in Diagram 8 for *NDD–NDH, NDDC–NDHC, NHD–NHH, NHDC–NHHC, USD–USH, USDC–USHC, FSD–FSH* and *FSDC–FSHC*. The differences for the ancestral series, which for the moment alone interest us, are shown by the positions of the circles while those for their offspring grown upon the comparison field are represented

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[1] The first part of this paper appeared in this journal, Vol. 46, pp. 313–343, 1912. The reader must consult it for all questions of purpose, materials, methods, etc.

[2] Harris, J. Arthur, "On the Relationship between Bilateral Asymmetry and Fertility and Fecundity," *Roux's Archiv.* In press.

TABLE IX

Series	Mean and Probable Error	Standard Deviation and Probable Error	Coefficient of Variation and Probable Error
NH	5.7170 ± .0106	.7762 ± .0075	13.5763 ± .1335
NHH	5.4126 ± .0049	.8569 ± .0035	15.8323 ± .0653
NHHH	5.3706 ± .0049	.7669 ± .0035	14.2803 ± .0656
NHD	4.7192 ± .0080	.8890 ± .0057	18.8383 ± .1245
NHDD	4.9985 ± .0074	.8064 ± .0052	16.1313 ± .1069
ND	4.0034 ± .0120	.6829 ± .0085	17.0587 ± .2181
NDD	4.3503 ± .0138	.7695 ± .0098	20.1638 ± .2340
NDDD	4.7161 ± .0163	.7083 ± .0080	15.0181 ± .1630
NDH	5.1375 ± .0070	.7957 ± .0049	15.4881 ± .0980
NDHH	5.1692 ± .0067	.7057 ± .0048	13.6517 ± .0936
NHHC	5.6607 ± .0109	.7852 ± .0077	13.8708 ± .1389
NHHHC	5.5853 ± .0107	.8099 ± .0076	14.4999 ± .1381
NHDC	5.6295 ± .0137	.8466 ± .0097	15.0390 ± .1762
NHDDC	5.6573 ± .0104	.7371 ± .0073	13.0289 ± .1315
NDDC	5.3701 ± .0147	.7409 ± .0104	13.7965 ± .1969
NDDDC	5.5337 ± .0127	.7397 ± .0090	13.3674 ± .1652
NDHC	5.4800 ± .0104	.7016 ± .0073	12.8031 ± .1362
NDHHC	5.4046 ± .0096	.7133 ± .0068	13.1973 ± .1282

TABLE X

Series	Mean and Probable Error	Standard Deviation and Probable Error	Coefficient of Variation and Probable Error
USS	5.5279 ± .0072	.8694 ± .0051	15.7280 ± .0945
USH	5.1491 ± .0095	.8196 ± .0067	15.9178 ± .1333
USHH	5.2392 ± .0116	.7151 ± .0082	13.6483 ± .1588
USD	4.7706 ± .0207	.8705 ± .0147	18.2481 ± .3174
USDD	4.7991 ± .0174	.7531 ± .0123	15.6925 ± .2628
USC	5.5866 ± .0093	.6978 ± .0066	12.4908 ± .1194
USSC	5.6992 ± .0109	.6992 ± .0077	12.2692 ± .1367
USHC	5.5548 ± .0125	.7348 ± .0088	13.2290 ± .1620
USHHC	5.5713 ± .0117	.7622 ± .0083	13.6816 ± .1511
USDC	5.5287 ± .0117	.7377 ± .0083	13.3431 ± .1522
USDDC	5.5244 ± .0121	.7236 ± .0086	13.0989 ± .1579

TABLE XI

Series	Mean and Probable Error	Standard Deviation and Probable Error	Coefficient of Variation and Probable Error
FSS	5.6864 ± .0080	1.0530 ± .0057	18.5181 ± .1033
FSH	5.5580 ± .0077	.7639 ± .0054	13.7443 ± .0991
FSHH	5.5150 ± .0075	.6873 ± .0053	12.4619 ± .0974
FSD	4.9579 ± .0142	.8022 ± .0101	16.1798 ± .2080
FSDD	5.0193 ± .0116	.6799 ± .0082	13.5471 ± .1668
FSC	6.0960 ± .0097	.7728 ± .0069	12.6768 ± .1145
FSSC	6.1840 ± .0106	.7816 ± .0075	12.6390 ± .1235
FSHC	6.0761 ± .0121	.8273 ± .0086	13.6149 ± .1437
FSHHC	6.0245 ± .0098	.8173 ± .0069	13.5660 ± .1168
FSDC	6.0525 ± .0137	.7853 ± .0097	12.9756 ± .1621
FSDDC	6.0616 ± .0107	.8144 ± .0076	13.4355 ± .1268

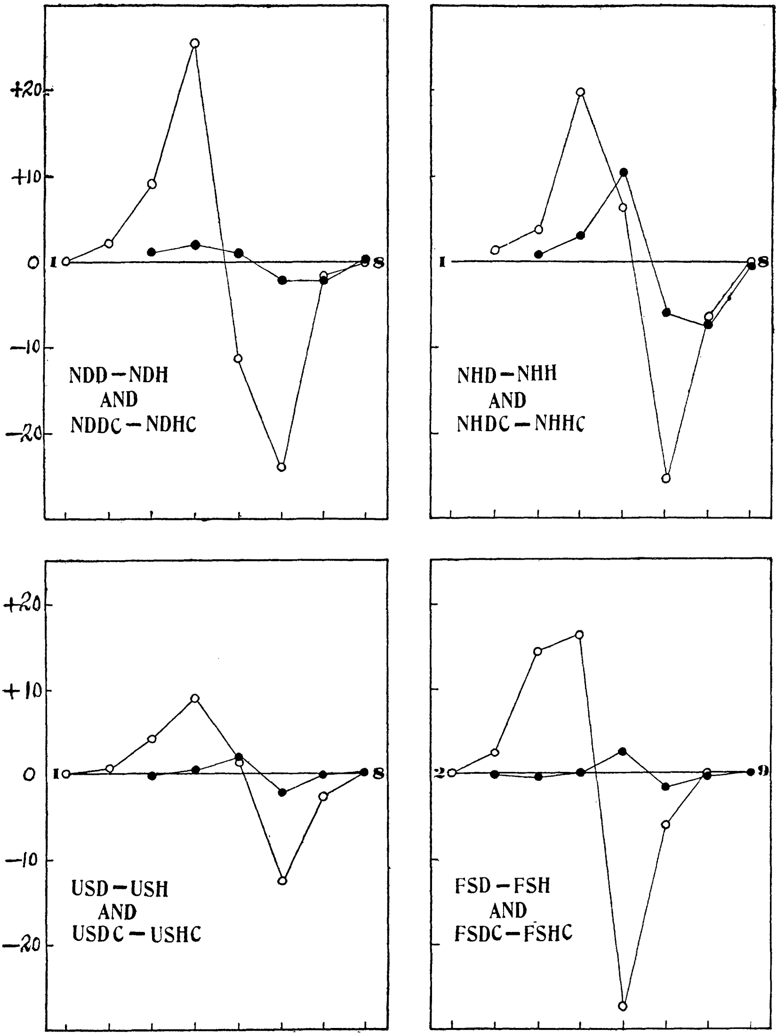

DIAGRAM 8. Differences in the percentage frequencies of various numbers of ovules per pod in luxuriant and depauperate cultures and in their offspring.

by solid dots. A profound influence of the starvation conditions is evident from these graphs. Relatively, the lower grades are much in excess, the higher grades much in defect in the starvation series.

The same fact is quite patent when one deals with the means of the series instead of comparing individual classes in the same lot. Clearly from Diagram 9:

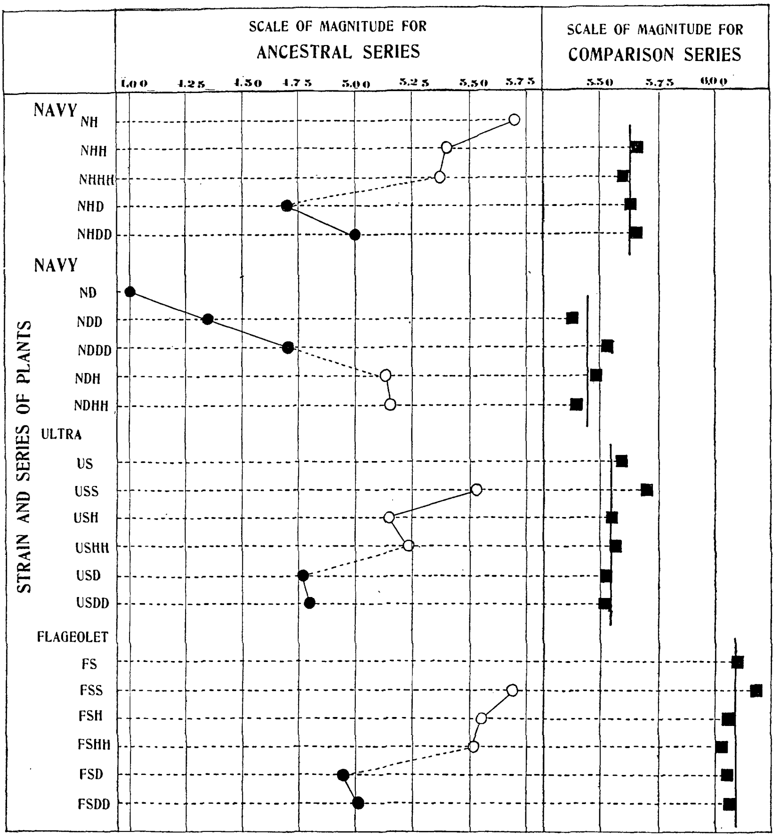

Diagram 9. Mean number of ovules per pod. Compare explanation of diagram 6.

(*a*) The means are in every case conspicuously lower for the starved than for the fed ancestral series.

(*b*) The means for the comparison series are closely similar: there is no striking superiority of fed over starved ancestry.

Here, accordingly, as for number of pods per plant, we must have recourse to numerical differences and their probable errors. The intra-ramal comparisons are made in Table XII. In three of the four cases, the starved seeds produce pods with more ovules, but in all cases the seed was a year older for one generation of ascendant

TABLE XII

Description of Material	Ancestors Starved for Two Generations	Ancestors Starved for Three Generations
Ancestors starved for one generation:		
USDC series:	*USDDC* series:	
Mean	− .0043 ± .0168	
Standard deviation	− .0141 ± .0119	
Coefficient of variation	− .2442 ± .2193	
FSDC series:	*FSDDC* series:	
Mean	+ .0091 ± .0174	
Standard deviation	+ .0291 ± .0123	
Coefficient of variation	+ .4599 ± .2059	
NHDC series:	*NHDDC* series:	
Mean	+ .0278 ± .0172	
Standard deviation	− .1095 ± .0121	
Coefficient of variation	−2.0101 ± .2198	
Ancestors starved for two generations:		
NDDC series:		*NDDDC* series:
Mean		+ .1636 ± .0194
Standard deviation		− .0012 ± .0137
Coefficient of variation		− .4291 ± .2571

starvation than for two. Compare the results for number of pods per plant, and for seeds per pod.

The inter-ramal differences appear in Tables XIII–XVI. Of the 28 comparisons, direct and cross, of mean number of ovules, 18 are negative and 10 positive; that is, in 18 cases, the plants with starved ancestry have a lower number of ovules per pod. Thus the deviation

TABLE XIII

Description of Material	Ancestors Starved for One Generation *NHDC*	Ancestors Starved for Two Generations *NHDDC*
Ancestors well fed for one generation:		
NDHC series:		
Mean	+ .1495 ± .0172	+ .1773 ± .0147
Standard deviation	+ .1450 ± .0121	+ .0355 ± .0103
Coefficient of variation	+2.2359 ± .2227	+ .2258 ± .1892
Ancestors well fed for two generations:		
NHHC series:		
Mean	− .0312 ± .0175	− .0034 ± .0151
Standard deviation	+ .0614 ± .0124	− .0481 ± .0106
Coefficient of variation	+1.1682 ± .2243	− .8419 ± .1913
NDHHC series:		
Mean	+ .2249 ± .0167	+ .2527 ± .0141
Standard deviation	+. 1333 ± .0118	+ .0238 ± .0100
Coefficient of variation	+1.8417 ± .2179	− .1684 ± .1836
Ancestors well fed for three generations:		
NHHHC series:		
Mean	+ .0442 ± .0174	+ .0720 ± .0149
Standard deviation	+ .0367 ± .0123	− .0728 ± .0105
Coefficient of variation	+ .5391 ± .2238	−1.4710 ± .1908

from the equality of division, if there were no influence of the environment of ascendants, is 4 ± 1.79. Of the 28 differences, 16 are thrice their probable errors; 9 are significantly negative and 7 significantly positive.

Taking averages, regarding signs, we have:

Navy, Within Strains, $A = +.0150$
Ne Plus Ultra, $A = -.0819$
White Flageolet, $A = -.0378$

TABLE XIV

Description of Material	Ancestors Starved for Two Generations *NDDC*	Ancestors Starved for Three Generations *NDDDC*
Ancestors well fed for one generation:		
NDHC series:		
Mean	− .1099 ± .0180	+ .0537 ± .0164
Standard deviation	+ .0393 ± .0127	+ .0381 ± .0116
Coefficient of variation	+ .9934 ± .2394	+ .5643 ± .2140
Ancestors well fed for two generations:		
NHHC series:		
Mean	− .2906 ± .0183	− .1270 ± .0167
Standard deviation	− .0443 ± .0129	− .0455 ± .0118
Coefficient of variation	− .0743 ± .2410	− .5034 ± .2159
NDHHC series:		
Mean	− .0345 ± .0175	+ .1291 ± .0159
Standard deviation	+ .0276 ± .0124	+ .0264 ± .0113
Coefficient of variation	+ .5992 ± .2349	+ .1701 ± .2090
Ancestors well fed for three generations:		
NHHHC series:		
Mean	− .2152 ± .0182	− .0516 ± .0166
Standard deviation	− .0690 ± .0129	− .0702 ± .0118
Coefficient of variation	− .7034 ± .2404	−1.1325 ± .2154

TABLE XV

Description of Material	Ancestors Starved for One Generation *USDC*	Ancestors Starved for Two Generations *USDDC*
Ancestors well fed for one generation:		
USSC series:		
Mean	− .1705 ± .0160	− .1748 ± .0163
Standard deviation	+ .0385 ± .0113	+ .0244 ± .0115
Coefficient of variation	+1.0739 ± .2047	+ .8297 ± .2088
USHC series:		
Mean	− .0261 ± .0171	− .0304 ± .0174
Standard deviation	+ .0029 ± .0121	− .0112 ± .0123
Coefficient of variation	+ .1141 ± .2223	− .1301 ± .2263
Ancestors well fed for two generations:		
USHHC series:		
Mean	− .0426 ± .0166	− .0469 ± .0168
Standard deviation	− .0245 ± .0117	− .0386 ± .0120
Coefficient of variation	− .3385 ± .2145	− .5827 ± .2186

TABLE XVI

Description of Material	Ancestors Starved for One Generation *FSDC*	Ancestors Starved for Two Generations *FSDDC*
Ancestors well fed for one generation:		
FSSC series:		
Mean	− .1315 ± .0173	− .1224 ± .0151
Standard deviation	+ .0037 ± .0122	+ .0328 ± .0107
Coefficient of variation	+ .3366 ± .2037	+ .7965 ± .1769
FSHC series:		
Mean	− .0236 ± .0183	− .0145 ± .0162
Standard deviation	− .0420 ± .0130	− .0129 ± .0115
Coefficient of variation	− .6393 ± .2166	− .1794 ± .1916
Ancestors well fed for two generations:		
FSHHC series:		
Mean	+ .0280 ± .0169	+ .0371 ± .0145
Standard deviation	− .0320 ± .0119	− .0029 ± .0102
Coefficient of variation	− .5904 ± .1997	− .1305 ± .1723

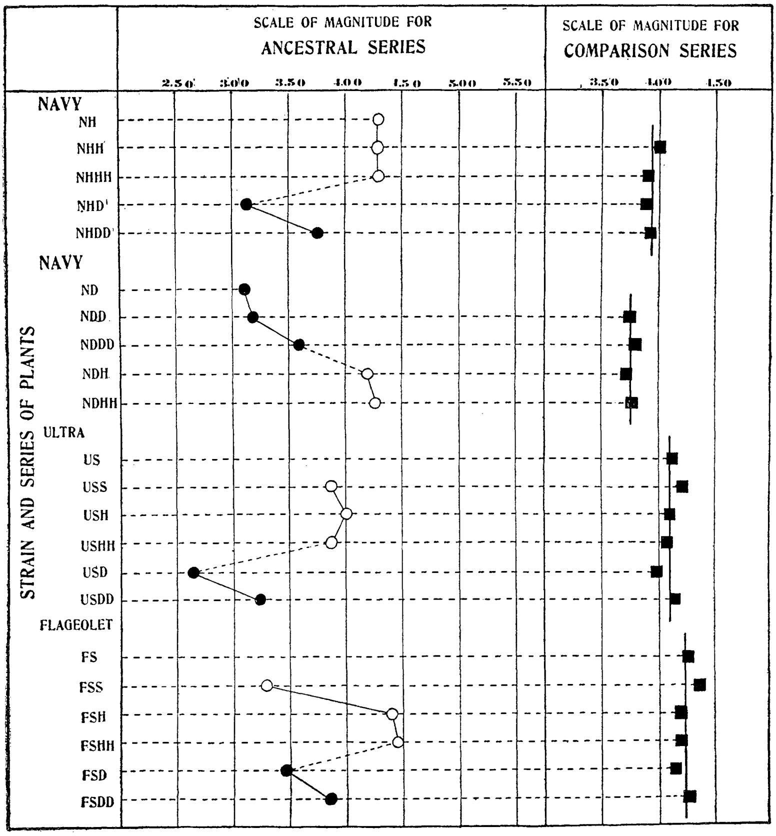

DIAGRAM 10. Mean number of seeds per pod. Compare explanation of diagram 6.

The results for Navy are slightly positive, for the other two varieties more conspicuously negative. The mean of the four varieties is —.0291.

Regarding only the 10 direct inter-ramal comparisons, we note that 7 are negative and 3 positive; 3 significantly negative and none significantly positive. The mean of the negative differences is —.0771, of the positive +.0794, of all —.0316.

The data are available for any one caring to work out the relationships for variabilities. The discussion of this point is reserved until further series are gotten.

C. Number of Seeds per Pod

Tables XVII–XIX give the essential biometric constants for number of seeds per pod. Diagram 10 justifies the same general conclusions for the mean number of seeds as were drawn from Diagram 9 for mean number of ovules per pod. In one case, however, the average for seeds is lower on a feeding plot than on the starvation fields.[3]

Appealing again to constants and their probable errors, we have the results set forth in the tables of fundamental differences, XX–XXIV.

The intra-ramal comparisons, Table XX, show three positive and one negative difference. Two of the positive differences are probably and the third possibly statistically significant. Note, however, that the age of the seed may be a disturbing factor. Compare the results for number of pods and number of ovules.

Of the 28 inter-ramal comparisons, Tables XXI–XXIV, 15 are negative and 13 positive.

In the usual manner, we get for the means:

Navy, Within Strains, $A = +.0078$
Ne Plus Ultra, $A = -.0711$
White Flageolet, $A = -.0383$

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[3] Why *FSS* plants did not mature their seeds well I have never been able to make out. The fact was noticed at harvest time.

For Navy the positive difference is trivial; the negative difference for Ne Plus Ultra and for White Flageolet is much larger.

Considering statistical significance to be indicated by a difference thrice its probable error, we find that 8 are significantly negative and 4 significantly positive. These 4, and 2 of the 8 significantly negative differences, fall in the comparisons between the two strains of Navy and hence can not be given much weight. Of the 20 interramal comparisons, direct and cross, within the same strain, 11 are negative and 9 are positive in sign. Of the 10 direct comparisons 5 are positive and 5 negative in

TABLE XVII

Series	Mean and Probable Error	Standard Deviation and Probable Error	Coefficient of Variation and Probable Error
NH	4.2555 ± .0193	1.4113 ± .0136	33.1634 ± .3538
NHH	4.2672 ± .0073	1.2893 ± .0052	30.2134 ± .1323
NHHH	4.2777 ± .0082	1.2802 ± .0058	29.9268 ± .1463
NHD	3.1269 ± .0117	1.2964 ± .0083	41.4611 ± .3068
NHDD	3.7493 ± .0116	1.2672 ± .0082	33.7974 ± .2420
ND	3.0971 ± .0196	1.1143 ± .0139	35.9804 ± .5017
NDD	3.1872 ± .0189	1.1984 ± .0134	37.6013 ± .4752
NDDD	3.5823 ± .0176	1.1709 ± .0124	32.6870 ± .3823
NDH	4.1797 ± .0108	1.2363 ± .0076	29.5786 ± .1982
NDHH	4.2512 ± .0112	1.1774 ± .0079	27.6963 ± .2003
NHHC	4.0115 ± .0194	1.3959 ± .0137	34.7973 ± .3812
NHHHC	3.8979 ± .0181	1.3683 ± .0128	35.1028 ± .3656
NHDC	3.9417 ± .0221	1.3616 ± .0156	34.5444 ± .4405
NHDDC	3.9333 ± .0191	1.3585 ± .0135	34.5397 ± .3816
NDDC	3.7550 ± .0254	1.2798 ± .0179	34.0838 ± .5301
NDDDC	3.8191 ± .0227	1.3215 ± .0161	34.6033 ± .4679
NDHC	3.7333 ± .0192	1.2989 ± .0136	34.7927 ± .4058
NDHHC	3.7751 ± .0173	1.2835 ± .0123	34.0005 ± .3603

TABLE XVIII

Series	Mean and Probable Error	Standard Deviation and Probable Error	Coefficient of Variation and Probable Error
USS	3.8781 ± .0114	1.3760 ± .0081	35.4817 ± .2330
USH	4.0097 ± .0146	1.2599 ± .0103	31.4219 ± .2810
USHH	3.8698 ± .0214	1.3253 ± .0151	34.2475 ± .4347
USD	2.6322 ± .0291	1.2235 ± .0206	46.4812 ± .9367
USDD	3.2268 ± .0297	1.2823 ± .0210	39.7382 ± .7453
USC	4.1269 ± .0175	1.3177 ± .0124	31.9296 ± .3297
USSC	4.2113 ± .0204	1.3126 ± .0144	31.1673 ± .3739
USHC	4.1045 ± .0226	1.3280 ± .0160	32.3553 ± .4283
USHHC	4.0832 ± .0204	1.3333 ± .0145	32.6536 ± .3899
USDC	3.9718 ± .0213	1.3403 ± .0150	33.7456 ± .4192
USDDC	4.1519 ± .0214	1.2752 ± .0151	30.7127 ± .3969

TABLE XIX

Series	Mean and Probable Error	Standard Deviation and Probable Error	Coefficient of Variation and Probable Error
FSS	3.2918 ± .0113	1.4772 ± .0080	44.8741 ± .2868
FSH	4.3907 ± .0131	1.3078 ± .0093	29.7865 ± .2288
FSHH	4.4563 ± .0143	1.3095 ± .0101	29.3856 ± .2450
FSD	3.4624 ± .0230	1.2993 ± .0163	37.5263 ± .5323
FSDD	3.8548 ± .0021	1.1991 ± .0145	31.1063 ± .4109
FSC	4.2865 ± .0172	1.3677 ± .0122	31.9072 ± .3113
FSSC	4.3643 ± .0198	1.4532 ± .0140	33.2987 ± .3541
FSHC	4.1941 ± .0200	1.3610 ± .0141	32.4494 ± .3701
FSHHC	4.1997 ± .0167	1.3941 ± .0118	33.1948 ± .3102
FSDC	4.1574 ± .0236	1.3596 ± .0167	32.7024 ± .4428
FSDDC	4.2710 ± .0178	1.3537 ± .0126	31.6950 ± .3220

TABLE XX

Description of Material	Ancestors Starved for Two Generations	Ancestors Starved for Three Generations
Ancestors starved for one generation:		
USDC series:	*USDDC* series:	
Mean	+ .1801 ± .0302	
Standard deviation	− .0651 ± .0213	
Coefficient of variation	−3.0329 ± .5773	
FSDC series:	*FSDDC* series:	
Mean	+ .1136 ± .0296	
Standard deviation	− .0059 ± .0209	
Coefficient of variation	−1.0074 ± .5475	
HDC series:	*HDDC* series:	
Mean	− .0084 ± .0292	
Standard deviation	− .0031 ± .0206	
Coefficient of variation	− .0047 ± .5828	
Ancestors starved for two generations:		
DDC series:		*DDDC* series:
Mean		+ .0641 ± .0341
Standard deviation		+ .0417 ± .0241
Coefficient of variation		+ .5195 ± .7070

sign, but none of the positive differences are statistically significant, while 3 of the negative differences are from 4 to 8 times their probable errors. The mean of the 5 negative differences is —.1371, of the 5 positive differences + .0482, of the whole series —.0445.

D. Weight of Seed

Throughout the experiments partially described in this paper, attention has been given to the weight of the individual seed. From the practical standpoint, the total weight of the seeds produced by the plant would have been a more desirable determination, but for several reasons this was not feasible.

For all the ancestral series, the seeds were weighed individually in units of .025 gram, but the excessive labor involved precluded this for the twenty comparison crops. Instead, the seeds of each series were mixed thoroughly among themselves and random drawings

TABLE XXI

Description of Material	Ancestors Starved for One Generation *NHDC*	Ancestors Starved for Two Generations *NHDDC*
Ancestors well fed for one generation:		
NDHC series:		
Mean	+ .2084 ± .0293	+ .2000 ± .0270
Standard deviation	+ .0627 ± .0207	+ .0596 ± .0192
Coefficient of variation	− .2483 ± .5989	− .2530 ± .5570
Ancestors well fed for two generations:		
NHHC series:		
Mean	− .0698 ± .0294	− .0782 ± .0272
Standard deviation	− .0343 ± .0208	− .0374 ± .0192
Coefficient of variation	− .2529 ± .5826	− .2594 ± .5394
NDHHC series:		
Mean	+ .1666 ± .0281	+ .1582 ± .0258
Standard deviation	+ .0781 ± .0199	+ .0750 ± .0183
Coefficient of variation	+ .5439 ± .5691	+ .5392 ± .5248
Ancestors well fed for three generations:		
NHHHC series:		
Mean	+ .0438 ± .0286	+ .0354 ± .0263
Standard deviation	− .0067 ± .0202	− .0098 ± .0186
Coefficient of variation	− .5584 ± .5725	− .5631 ± .5285

TABLE XXII

Description of Material	Ancestors Starved for Two Generations *NDDC*	Ancestors Starved for Three Generations *NDDDC*
Ancestors well fed for one generation:		
NDHC series:		
Mean	+ .0217 ± .0318	+ .0858 ± .0297
Standard deviation	− .0191 ± .0225	+ .0226 ± .0211
Coefficient of variation	− .7089 ± .6676	− .1894 ± .6194
Ancestors well fed for two generations:		
NHHC series:		
Mean	− .0256 ± .0320	− .1924 ± .0299
Standard deviation	− .1161 ± .0225	− .0744 ± .0211
Coefficient of variation	− .7135 ± .6529	− .1940 ± .6035
NDHHC series:		
Mean	− .0201 ± .0307	+ .0440 ± .0285
Standard deviation	− .0037 ± .0217	+ .0380 ± .0203
Coefficient of variation	+ .0833 ± .6409	+ .6028 ± .5905
Ancestors well fed for three generations:		
NHHHC series:		
Mean	− .1429 ± .0312	− .0788 ± .0290
Standard deviation	− .0885 ± .0220	− .0468 ± .0206
Coefficient of variation	− .0190 ± .6440	− .4995 ± .5938

TABLE XXIII

Description of Material	Ancestors Starved for One Generation *USDC*	Ancestors Starved for Two Generations *USDDC*
Ancestors well fed for one generation:		
USSC series:		
Mean	− .2395 ± .0295	− .0594 ± .0296
Standard deviation	+ .0277 ± .0208	− .0374 ± .0209
Coefficient of variation	+2.5783 ± .5617	− .4546 ± .5453
USHC series:		
Mean	− .1327 ± .0310	+. 0474 ± .0311
Standard deviation	+ .0123 ± .0219	− .0528 ± .0220
Coefficient of variation	+1.3903 ± .5993	−1.6426 ± .5840
Ancestors well fed for two generations:		
USHHC series:		
Mean	− .1114 ± .0295	+ .0687 ± .0296
Standard deviation	+ .0070 ± .0209	− .0581 ± .0209
Coefficient of variation	+1.0920 ± .5725	+1.9409 ± .5564

TABLE XXIV

Description of Material	Ancestors Starved for One Generation *FSDC*	Ancestors Starved for Two Generations *FSDDC*
Ancestors well fed for one generation:		
FSSC series:		
Mean	− .2069 ± .0308	− .0933 ± .0266
Standard deviation	− .0936 ± .0218	− .0995 ± .0188
Coefficient of variation	− .5963 ± .5670	−1.6037 ± .4786
FSHC series:		
Mean	− .0367 ± .0309	+ .0769 ± .0268
Standard deviation	− .0014 ± .0219	− .0073 ± .0189
Coefficient of variation	+ .2530 ± .5771	− .7544 ± .4906
Ancestors well fed for two generations:		
FSHHC series:		
Mean	− .0423 ± .0289	+ .0713 ± .0244
Standard deviation	− .0345 ± .0204	− .0404 ± .0173
Coefficient of variation	− .4924 ± .5406	−1.4998 ± .4471

made for mass weighings.[4] It is on these samples of 2,000 or more seeds (weighed after drying for several months)[5] that the averages are based.

Seed weight will be touched rather lightly in this paper. This is in part due to the fact that the seeds for the comparison series could not be weighed individually, thus affording data from which the variabilities and probable errors might be calculated. It is in part due to the fact that (as will be clear later) the starvation conditions available seem not to have affected seed weight as they did the other characters with which we deal.

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[4] This was the plan for all but *USC* and *FSC*, where 100 seeds, or as many as were available, were weighed *en masse* for each line. From these, the general population mean was calculated.

[5] The plants were harvested and dried in an empty greenhouse in the early autumn of 1910; stored in an unheated building for the early part of the winter; counted during a period extending from January to early April; and left in the laboratory till weighing, some time in June.

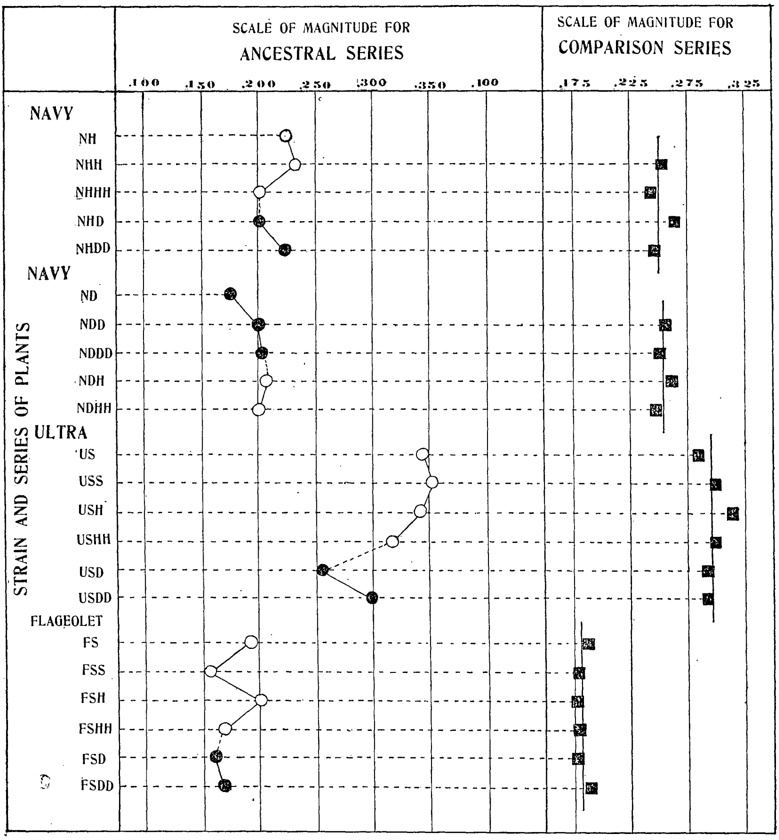

DIAGRAM 11. Mean weight of seeds. Compare diagrams 6, 9 and 10.

The mean weight for both ancestral and comparison series are shown in decimals of grams in Table XXV.

That seed weight is a character influenced by environmental conditions is apparent from the scatter of the means in the ancestral field of Diagram 11 as compared with their closeness to line in the comparison panel. But the diagram also shows at once that seed weight has not been influenced by the starvation conditions as other characters have. Whereas, with a single exception, number of pods per plant, number of ovules per pod and number of seeds per pod were all conspicuously reduced, seed weight is sometimes higher, sometimes lower, on the starvation plots. Of the 28 differences, 21 are negative in sign, as compared with 28 for pods per plant and ovules per pod and 27 for seeds per pod.

Expressing numerically the same differences for the ancestral series as are usually taken for the comparison series, we find for comparisons within the strains:

TABLE XXV

Ancestral Series			Comparison Series		
Series	N	Mean	Series	N	Mean
FS	3,000	.19322	*FSC*	7,562	.18587
FSS	3,740	.15636	*FSSC*	2,000	.18026
FSH	2,122	.20039	*FSHC*	2,000	.17893
FSHH	1,788	.16813	*FSHHC*	2,000	.18145
FSD	1,989	.16140	*FSDC*	2,000	.17816
FSDD	1,643	.16783	*FSDDC*	2,000	.19027
US	2,391	.34491	*USC*	9,879	.28450
USS	3,271	.35349	*USSC*	2,000	.29933
USH	1,165	.34261	*USHC*	2,000	.31450
USHH	530	.31642	*USHHC*	2,000	.30147
USD	1,002	.25474	*USDC*	2,000	.29170
USDD	789	.29948	*USDDC*	2,000	.29284
NHH	7,334	.23186	*NHHC*	2,000	.25430
NHHH	5,601	.20274	*NHHHC*	2,000	.24407
NHD	6,630	.20073	*NHDC*	2,000	.26616
NHDD	5,029	.22293	*NHDDC*	2,000	.24669
NDD	2,362	.19968	*NDDC*	2,000	.25849
NDDD	1,946	.20374	*NDDDC*	2,000	.25207
NDH	3,227	.20879	*NDHC*	2,000	.26248
NDHH	2,433	.20261	*NDHHC*	2,000	.24815

Navy, $\Delta = -.0047$
Ne Plus Ultra, $\Delta = -.0604$
White Flageolet, $\Delta = -.0103$
General Average, $\Delta = -.0231$

Thus there appears to be a distinct influence of the depauperization of the individual upon the weight of the seeds which it produces. But modification of weight is very slight indeed as compared with that of the other characters.

Considering now the weight of the seeds produced by the comparison plants, we note that of the 28 differences which may be taken (within and between strains) between plants of luxuriant and those of depauperate ancestry, 15 are negative and 13 are positive in sign, a deviation of only 1 ± 1.79 from the expected 14:14 ratio.

Of the individual differences, the largest is .023 gram, while most of them fall, towards zero. Averaging we get:

Positive Differences,	+ .00915 gr.
Negative Differences,	— .00831 gr.
All Differences,	— .00020 gr.

Surely values as low as this can not give much weight to the assertion that depauperization of the parents has had any influence upon the weight of the seed of the offspring plants.

Looked at in a preliminary and superficial way (and it hardly seems worth while to go into the matter more minutely until other data are tabled and reduced), the data seem to indicate that the weight of the seed is a character much less directly dependent upon cultural conditions than are the vegetative characters of the plant. Conditions which reduce these latter may not materially affect seed weight.

Possibly, the environmental complexes available were such as to affect certain characteristics of the ancestral plants, while leaving others, *i. e.*, seed weight, unmodified. Possibly, seed weight is a character little affected by external conditions of any kind. These are questions which can only be solved by further experiments designed to determine whether some environmental complexes regularly affect seed weight while others do not, and to ascertain what influence, if any, such reduction has upon the characteristics of offspring seeds.

E. Combination Characters

Some characteristics are combinations of two or more individual measurements. Such are, for example, the correlation between two dimensions, or the ratio of the one to the other.

The only case of this kind to be considered here is the coefficient of fecundity, which is simply the ratio of the total seeds matured by a population of pods to the total ovules formed. The values are given in Table XXVI.

For the ancestral series all but 2 of the 20 comparisons within strains show lower fecundity in the starved series. Taking averages:

Navy, Within Strains, $A = -.0790$
Ne Plus Ultra, $A = -.1178$
White Flageolet, $A = +.0075$

Thus Navy and Ne Plus Ultra mature about 7–11 per cent. more of their ovules on feeding than on starvation fields. Apparently, White Flageolet is not affected.

TABLE XXVI

Ancestral Series			Comparison Series		
Series	Pods	C.F.	Series	Pods	C.F.
FS	——	——	*FSC*	2,876	.7387
FSS	7,809	.5789	*FSSC*	2,457	.7057
FSH	4,541	.7899	*FSHC*	2,117	.6903
FSHH	3,837	.8080	*FSHHC*	3,180	.6971
FSD	1,449	.6984	*FSDC*	1,506	.6869
FSDD	1,556	.7680	*FSDDC*	2,646	.7046
US	——	——	*USC*	2,569	.7032
USS	6,605	.7015	*USSC*	1,888	.7389
USH	3,406	.7787	*USHC*	1,570	.7389
USHH	1,743	.7386	*USHHC*	1,936	.7329
USD	802	.5518	*USDC*	1,810	.7184
USDD	851	.6724	*USDDC*	1,619	.7516
NHH	14,029	.7884	*NHHC*	2,355	.7087
NHHH	11,230	.7965	*NHHHC*	2,614	.6979
NHD	5,581	.6625	*NHDC*	1,733	.7002
NHDD	5,449	.7501	*NHDDC*	2,308	.6953
NDD	1,827	.7326	*NDDC*	1,159	.6992
NDDD	2,018	.7596	*NDDDC*	1,542	.6901
NDH	5,955	.8136	*NDHC*	2,077	.6813
NDHH	5,019	.8224	*NDHHC*	2,494	.6985

For the comparison series grown from these seeds, we find that of the 20 comparisons, direct and cross, within the strains, 12 show lower and 8 show higher fecundity in the offspring of starved plants. The means are:

Navy, $A = -.00036$
Ne Plus Ultra, $A = -.00615$
White Flageolet, $A = -.00196$

Discussion of such differences is obviously superfluous.

IV. Recapitulation, Discussion and Tentative Conclusions

The purpose of the series of investigations, described in part, is to ascertain whether the depauperization of the individual through the environmental complexes constituting "poor" agricultural conditions, influences the characteristics of its offspring, and if so, how much. The problem of the chemical and physical "causes" of the depauperization has received the most intensive experimental consideration. The question of the influence of the surroundings of the ascendants upon the characteristics of the descendants has been much more a matter of speculation. Yet the second of these problems is of obvious importance to the agriculturist and of interest to the evolutionist concerned with environmental factors. The time seems ripe, therefore, for its consideration on the basis of extensive quantitative experimental data.

Notwithstanding the great progress which has been made in the investigation of the relationship of the chemical and physical properties of the substratum to the characteristics of the plant, the diversity of results and the clash of theories show that we have only entered the edge of this field of research. In consideration of these facts, and especially in view of the all but unsurmountable difficulties of controlling in large experiments the conditions of growth of flowering plants, it has seemed necessary in first studies to choose merely good and bad growing conditions as indicated by yields in actual cultures. Thus the methods are avowedly and intentionally of the rough and ready sort. If in such experiments an unquestionable influence of the conditions of growth of the ascendants upon the characteristics of the descendants be demonstrated, it will be worth while to determine the weight to be given to individual physical and chemical factors in the ascendant environment. If, on the other hand, there be no detectable effect of ancestral depauperization, then the cost of elaborate batteries of experiments had better be devoted to some other problem.

This first study is based upon three varieties of one species, *Phaseolus vulgaris*. The conclusions should not, therefore, be extended to other forms with different demands upon the soil, habits of growth or type of seed. This is true not merely on general principles, but is especially important because of the well-known capacity of this species for growth under adverse conditions.

The characters considered are number of pods per plant, number of ovules formed and number of seeds matured per pod, ratio of total seeds ripened to total ovules laid down—the coefficient of fecundity—and weight of seeds.

Constants are based upon the countings of number of ovules and seeds in about 130,000 pods and weighings of over 110,000 carefully selected seeds. But these observations were drawn from only 21,000 individual plants. As the results in the body of the paper show, these numbers are too small rather than unnecessarily large for a problem of this delicacy. I believe, however, that they are sufficiently large to bring the probable errors of random sampling low enough that dangers of erroneous conclusions lie rather in the inevitable experimental (and to a less extent observational) errors.

Bearing in mind the difficulties to be surmounted and the consequent possibilities of error, we draw the following tentative conclusions.

Environmental conditions which greatly reduce number of pods per plant, number of ovules formed per pod and number of seeds matured per pod, affect to a less degree the relative number of seeds matured, *i. e.*, the coefficient of fecundity, and have but little effect upon seed weight.

The influence of the modification of the ascendants upon the characteristics of the descendants is extremely slight. There seems, nevertheless, to be a definite reduction in the number of pods per plant and number of ovules per pod. There is also a possible lowering of the absolute and relative number of seeds per pod. Apparently, there is no modification of seed weight.

COLD SPRING HARBOR, N. Y.